

INHALATION EXPOSURE OF COMMODITY
HANDLERS TO METHYL BROMIDE IN
YOLO COUNTY, CALIFORNIA, OCTOBER 1983

by

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SUMMARY

Inhalation exposure of employees, handling fumigated commodities, to methyl bromide was measured at two walnut processing plants in Yolo County. Exposures were measured with charcoal tube air samples collected from employee breathing zones. Exposures to methyl bromide, measured from three to 20 minutes, ranged from 0.5 to 33.4 ppm outside of respiratory protection devices. Methyl bromide concentrations in the vicinity of chambers were measured with grab sampling utilizing colorimetric detector tubes. This study was conducted to assist the County Agricultural Commissioner's staff in establishing restricted materials permit conditions for the use of methyl bromide.

INTRODUCTION

Methyl bromide is a colorless, odorless, tasteless, non-flammable gas which is used as a fumigant in a variety of pest-control situations. Reported use of methyl bromide in California for 1982 was nearly 6.3 million pounds (1).

Inhaling excessive concentrations of methyl bromide can lead to irritation and edema in the lung, numerous effects in the nervous system (paralysis, convulsions, coma, psychological disorders) and uremia. Liquid methyl bromide can cause burns on the skin, and can penetrate intact skin. Toxic effects following methyl bromide exposure to humans have been documented in a number of cases (2). The Cal/OSHA Permissible Exposure Limit (PEL) for methyl bromide is 15 ppm based on an 8-hour time weighted average (TWA). The Cal/OSHA excursion limit (short-term exposure) is 25 ppm limited to a five-minute period in an 8-hour day (3). The American Conference of Governmental Industrial Hygienists (ACGIH) recommend a Threshold Limit Value (TLV) of five ppm, based upon an 8-hour TWA, with a Short-Term-Exposure-Limit of 15 ppm (2).

A brief review of the literature revealed few studies of commodity handler exposure to methyl bromide published in the past 15 years. Employees performing commodity fumigations were monitored for methyl bromide exposure by the California Division of Occupational Safety and Health (Cal/OSHA) and the Department of Food and Agriculture in 1982. In these studies, employee exposures (measured with breathing zone samples) to methyl bromide ranged from 0.1 to 5.0 ppm (4, 5).

Commodity fumigation in standing chambers involves the following procedures:

- 1) Loading the commodity into the chamber, normally with a forklift. The chamber door is then closed and sealed.
- 2) Fumigant is injected into the chamber from a pressurized cylinder through a closed system. This activity is performed by a certified applicator.
- 3) The commodity is then exposed from twelve to twenty-four hours. Unauthorized entry into the chamber is prevented by locks on the doors and warning signs on the chamber.
- 4) The gas is then exhausted from the chamber. Practices vary between methyl bromide users; however, with many chambers, exhaust fans are used with the door cracked to allow in make-up air. Some chambers are not equipped with exhaust fans. In these cases, the door(s) is opened and natural ventilation is used; this is a questionable practice which is not encouraged.

This study was requested by the Yolo County Agricultural Commissioner's Office to establish conditions for the fumigant users' restricted materials permits. Data from this study were used to determine the adequacy of ventilation and administrative controls for minimizing exposure to methyl bromide. The purpose of this study was to assist the Agricultural Commissioner in determining time periods required for exhausting methyl bromide from the chamber and aerating the commodities prior to allowing workers into the chamber to unload the commodities.

Exposures of commodity handlers to methyl bromide were studied at two nut processing facilities located in Yolo County. Facility A was a large commercial nut processing plant which has six fumigation chambers located on four sites. The chambers were of plywood construction and built on concrete pads. They were closed with rubberized tarpaulin doors which were clamped to the frame and sealed at the bottom with sand snakes. Methyl bromide was injected through a closed system plumbed with copper lines. All chambers have previously been smoke-tested for air-tightness.

The chambers were from 12,000 to 13,000 cubic feet in volume. Five are ventilated with fans exhausting 1,700 cubic feet per minute, though the sixth chamber was recently equipped with a fan exhausting nearly 4,000 cubic feet per minute.

Each chamber was used twice a day. The operating procedure at this plant was closed system injection and fumigation lasting 12 hours; exhaust ventilation removing methyl bromide from the chamber interior required one to 2.5 hours; opening the door, turning off fans and aerating the commodity with natural ventilation required 30 minutes; unloading the commodity by forklift required 30 minutes to one hour. The commodities were stored outdoors for a day before further processing. With the exception of driving the forklifts, the manual operations (injection, opening exhaust vents, testing the chamber atmosphere or opening the doors) normally brought employees in proximity of the chamber one to four times each day. Each of these operations were commonly accomplished in three to ten minutes. Ventilation operations involved opening a valve from the chamber to an exhaust stack and fan, operating the fan and "cracking" the tarp to provide make-up air. The doors were opened by removing the clamps and rolling up the tarp. A forklift driver made several trips into the chamber during unloading; however, they usually spent less than 30 seconds inside the chamber each trip.

The commodities fumigated were shelled almond and walnuts, and unshelled walnuts loaded in wooden bins. One hundred percent methyl bromide supplied by various manufacturers was applied at three pounds per 1,000 cubic feet of chamber volume. Chloropicrin was not used. Fumigations were performed according to written procedures (specifying fumigation procedures, ventilation requirements, hazardous gas detection procedures and respiratory protection requirements) which were posted at each chamber site.

Facility B was a small nut processing plant fumigating walnuts in two 40 foot seavan containers. The chambers were not equipped with exhaust fans. The chambers were used once each day. The operating procedure involved injection of methyl bromide through a closed system and fumigation (12 hours), then opening the doors for aeration (one hour) before unloading the commodity. One hundred percent methyl bromide, supplied by various manufacturers, was used without chloropicrin. Two employees were responsible for fumigation operations at this facility.

MATERIALS AND METHODS

Inhalation exposures of employees ventilating chambers, opening doors, testing chamber atmospheres or unloading commodities were monitored with air samples. Personal air samples were drawn with charcoal sorbent tubes and

battery-powered air sampling pumps worn by the employees. Methyl bromide concentrations were measured only while employees were working near a chamber; samplers were removed when a chamber operation was completed. Sampling durations ranged from three to 20 minutes. All personal samples were analyzed for methyl bromide with gas chromatography.

Instantaneous measurements of methyl bromide concentrations were made with colorimetric detector tubes. Detector tube samples were collected at the entrance when chamber doors were opened and prior to employees unloading commodities. A few detector tube samples were collected, within bins or over the surface of bins, to determine methyl bromide concentrations off-gassing from the commodities.

RESULTS

Inhalation exposure of employees operating chamber ventilation fans, opening chamber doors or unloading commodities ranged from none detected to 17.5 ppm methyl bromide in samples monitoring three to 20 minutes of exposure. A concentration of 33.4 ppm was measured from an employee (equipped with self-contained-breathing apparatus) testing the chamber atmosphere during the aeration period prior to allowing employees to unload commodities. Cal/OSHA regulation requires atmospheric testing prior to allowing unprotected employees into a chamber (6).

Detector tube measurements indicated that methyl bromide concentrations inside chambers, one to five minutes after opening the doors, ranged from 35 to 85 ppm. Methyl bromide concentrations at the threshold of chambers one to five minutes after opening the doors ranged from three to five ppm. Concentrations inside chambers after aeration (30 minutes to one hour) ranged from three to five ppm.

Concentrations measured inside bins of nuts ranged from 80 to 100 ppm; however, concentrations a few inches over the bins were three ppm.

DISCUSSION

Based on the results of this survey, the amounts of time allotted for exhausting methyl bromide from the chamber and for aeration of the commodity appeared adequate to maintain employee exposures below the PEL. One unexpected occurrence was a 17 ppm concentration measured from a forklift driver at facility A after a 30-minute aeration period. The sample from the employee opening the chamber door showed no detectable methyl bromide (less than 0.06 ppm), and a detector tube sample collected from four feet inside the chamber also showed no detectable methyl bromide (less than 3 ppm). The driver had temporarily modified his unloading procedure (unloading bins from front to back rather than across the width of the chamber) allowing him to spend more time inside the chamber while it was full of bins. The chamber was also only 2/3 full when fumigated which probably meant less methyl bromide would be absorbed by the commodity. Presently, it is not understood why the .pa exposure of the forklift driver was much higher than the exposure of the employee opening the chamber door.

At facility B, despite the lack of exhaust ventilation for the chamber, methyl bromide concentrations measured were relatively low during aeration and unloading. This was possibly due to absorption of methyl bromide into the nuts. Detector tube samples collected inside walnut bins showed high concentrations of methyl bromide (80 to 100 ppm) in the interstices of the nuts. One sample, collected a few inches over a bin, showed three ppm indicating that methyl bromide released from the nuts diffuses readily in open air. These results should be considered preliminary; further sampling is needed to confirm the concentration of methyl bromide offgassing from fumigated commodities. Also, further sampling is needed to determine if ventilation controls should be installed on the chambers, including monitoring the employee while unloading the chamber (at facility B, only the door-opening operation was monitored; the employee declined to wear a sampler while driving a forklift).

The offgassing of methyl bromide should be considered when selecting storage locations for fumigated nuts. Storage locations should be well ventilated (preferably outdoors) and located away from work areas to minimize exposure to employees working on the nut processing lines. Employees working on the nut processing lines (washing, sorting, grading or packing nuts) are also exposed to low levels of methyl bromide offgassing from fumigated nuts. These levels will fluctuate depending upon the storage time after fumigation and the ventilation present in the work areas. Employees working in proximity of fumigation chambers (fumigators and forklift drivers) have the highest peak exposures, though all employees at nut processing plants are potentially exposed to low levels of methyl bromide.

CONCLUSIONS

Inhalation exposures to methyl bromide of employees ventilating fumigation chambers or unloading commodities were monitored with air samples. The exposures ranged from none detected (less than 0.06 ppm) to 33.4 ppm in samples covering three to 20 minutes of work. Colorimetric detector tube samples collected inside the chambers shortly after opening (following 30 minutes of ventilation) detected 35 to 85 ppm.

After 30-minute aeration with doors open, concentrations inside the chamber declined to three to five ppm.

In one instance a forklift driver was exposed to a methyl bromide concentration of 17 ppm, exceeding the Cal/OSHA 8-hour PEL (a second employee wearing SCBA was temporarily in an atmosphere containing 33 ppm). In this study, most employee exposures and environmental concentrations, measured when employees entered chambers, were below the Cal/OSHA PEL; exposures at one facility should be re-monitored to determine if ventilation controls should be installed on the fumigation chambers.

REFERENCES

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6. Title 8, California Administrative Code, Section 5222C.

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TABLE 1

INHALATION EXPOSURE OF COMMODITY HANDLERS TO
METHYL BROMIDE (CHARCOAL TUBE SAMPLES)

FACILITY A

<u>Date Sampled</u>	<u>Time Sampled</u>	<u>Operation Monitored</u>	<u>Sampling Duration (min.)</u>	<u>Methyl Bromide Detected (ppm)</u>
10/18/83	1355	Ventilating chamber	3	1.7
10/25/83	1430	Testing chamber atmosphere	5	33.4 ^{a/}
10/18/83	1508	Opening door	6	1.5
10/25/83	0700	Opening door	5	ND ^{b/}
10/25/83	1310	Opening door	10	0.5
10/18/83	1545	Unloading chamber (forklift driver)	15	0.8
10/25/83	0730	Unloading chamber (forklift driver)	20	17.5

FACILITY B

<u>Date Sampled</u>	<u>Time Sampled</u>	<u>Operation Monitored</u>	<u>Sampling Duration (min.)</u>	<u>Methyl Bromide Detected (ppm)</u>
10/18/83	0930	Opening door	5 ^{c/}	0.8

^{a/} Employee wore a self-contained breathing apparatus (SCBA). Sample was drawn outside of SCBA. The detector tube measurement by this employee showed 20 ppm.

^{b/} ND means none detected, minimum detectable level is 0.06 ppm.

^{c/} Actual time required to open doors was one minute. The employee operating the forklift was not monitored.

TABLE 2

METHYL BROMIDE CONCENTRATIONS MEASURED
WITH COLORIMETRIC DETECTOR TUBES

FACILITY A, OCTOBER 18, 1983

<u>Time Sampled</u>	<u>Location</u>	<u>Methyl Bromide Detected (ppm)</u>
1510	Immediately after opening chamber door, at "arms's length" between bins.	85
1515	Two feet from chamber threshold.	3
1545	"Arm's length" between bins, 30 minutes aeration.	5

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<u>Time Sampled</u>	<u>Location</u>	<u>Methyl Bromide Detected (ppm)</u>
0705	Four feet inside chamber five minutes after opening door.	<3
1315	Four feet inside chamber after five minutes aeration.	<80
1320	Threshold of chamber after ten minutes aeration.	5
1345	Four feet inside chamber after 30 minutes aeration.	5

FACILITY B, OCTOBER 18, 1983

<u>Time Sampled</u>	<u>Location</u>	<u>Methyl Bromide Detected (ppm)</u>
0930	Measured at chamber threshold, immediately after opening door.	<3
0935	Measured "arm's length" between bins, five minutes aeration.	35
0940	Inside a bin of nuts.	85
1035	Measured "arm's length" between bins, one hour aeration.	<3
1040	Inside a bin of nuts.	>100
1055	Two inches over a bin of nuts.	3